USACERL Technical Report P-90/26
August 1990

US Army Corps
of Engineers
Construction Engineering
Research Laboratory

Evaluation of Computer-Based Equipment Management Systems for Equipment Shops in U.S. Army Directorates of Engineering and Housing

by
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Equipment shops in the U.S. Army Directorates of Engineering and Housing (DEHs) normally use written files to maintain records and inventories, and to author reports. This report describes criteria for selection and implementation of commercially available, computer-based vehicle and equipment maintenance management systems that can automate those tasks. Capabilities of appropriate management systems are described, including the use of bar code technology. Two systems (JP Systems' ShopFax, and Prototype's EMS/PC) were selected for test implementation at three Army installations (Fort Lee, VA; Fort Riley, KS; and Fort Meade, MD). This report details the experiences of each installation with the introduction of a computer-based management system, and the benefits derived from that introduction. Recommendations are made as to the circumstances under which each system is more suitable.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 1990	Final

4. TITLE AND SUBTITLE

Evaluation of Computer-Based Equipment Management Systems for Equipment Shops in U.S. Army Directorates of Engineering and Housing

5. FUNDING NUMBERS

PE - 4A162734
PR - AT41
TA - SB
WU - CGO

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Construction Engineering
Research Laboratory
P.O. Box 4005
Champaign, IL 61824-4005

8. PERFORMING ORGANIZATION REPORT NUMBER

TR P-90/26

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

US Army Engineering and Housing Support Center
ATTN: CEHSC-FB-I
Ft. Belvoir, VA 22060-5580

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

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14. SUBJECT TERMS

Directorate of Engineering and Housing
management information system
equipment

15. NUMBER OF PAGES

34

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

FOREWORD

This research was conducted for the U.S. Army Engineering and Housing Support Center (USAEHSC), Directorate of Facilities Engineering. The investigation of commercial software was funded under Project 4A162784AT41, "Military Facilities Engineering Technology," Work Unit SB-CG0, "DEH Equipment Maintenance Management System"; field testing of the selected systems was funded under the Facilities Engineering Applications Program (FEAP), Project FV9, "DEH Equipment Maintenance Management System." The USAEHSC Technical Monitor was Mr. Walter Seip, USAEHSC-FB-I.

The work was performed by the U.S. Army Construction Engineering Research Laboratory (USACERL), Facility Systems Division (FS). Mr. Donald Hicks was Principal Investigator and Mr. Michael Fuerst, Associate Investigator. Assistance was provided by the Directors of Engineering and Housing of: Fort Lee, VA (Mr. Milton Emory); Fort Meade, MD (Mr. Karl Wolfe); and Fort Riley, KS (Mr. Vilo Walston). Dr. Michael O'Connor is Chief of USACERL-FS. The USACERL technical editor was Mr. William J. Wolfe, Information Management Office.

COL Everett R. Thomas is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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EVALUATION OF COMPUTER-BASED EQUIPMENT MANAGEMENT SYSTEMS FOR EQUIPMENT SHOPS IN U.S. ARMY DIRECTORATES OF ENGINEERING AND HOUSING

1 INTRODUCTION

Background

Directorates of Engineering and Housing (DEHs) on many Army installations manage and maintain fleets of equipment (vehicles, and construction and groundskeeping equipment) used for buildings and grounds maintenance. Each fleet may have from 600 to 1500 items; each item goes through use and maintenance cycles, and accompanying cost-accounting procedures.

The DEH must handle dispatching and assignment of equipment, and either perform or coordinate preventive maintenance (PM) and repairs. On some installations, the DEH has in-house mechanics to perform PM and minor to moderate repairs. Extensive work may be sent to the Directorate of Logistics or to a commercial repair shop. Exactly what work gets done by the DEH varies among installations.

Current accounting practices do not properly cost equipment usage. For example, depreciation on equipment is recorded against only certain construction projects, and not against maintenance and repair work. Thus, the DEH has no means to determine realistically how to associate shops and work orders with equipment costs.

In the past, DEH equipment operating and maintenance costs have been recorded manually. Various forms register fuel and oil usage, repair and maintenance expenditures, work orders, and utilization records. A typical DEH equipment shop has several cabinet files filled with completed forms too numerous and complex to consolidate into reports to improve management of the equipment fleet.

For example, DEH equipment managers cannot easily determine:

1. Which equipment or groups of equipment experience excessive repair costs
2. Which equipment is being over- or underutilized
3. Which users in the DEH organization subject equipment to more wear
4. Which shop mechanics are more efficient for which types of tasks
5. When equipment has exceeded its economic life
6. How to cost equipment downtime
7. How to decrease equipment downtime
8. What is the actual cost of owning and operating an item of equipment

9. How much to charge a job for equipment usage

10. How to determine a realistic depreciation schedule for equipment

11. What parts in inventory are obsolete

12. Which vendor supplies the best price for parts

13. How many of a given part have been used during a specified time period.

If this information were available, higher authority could more accurately assess relative efficiencies of DEH equipment management at various installations, as well as better budget for equipment replacement.

Department of the Army Pamphlet 738-750, "The Army Maintenance Management System (TAMMS)" (01 Dec 83) describes the record-keeping requirements for vehicle and equipment maintenance and management, but provides no guidance for making constructive use of the information.

Objectives

The objectives of this project were:

1. To develop criteria for selecting and implementing commercially available computer-based vehicle and equipment maintenance management systems for the DEH organizations at Army installations

2. To select the most appropriate management system(s) for further testing

3. To field test the selected system(s) at three selected installations: Fort Lee, Virginia; Fort Riley, Kansas; and Fort Meade, Maryland

4. To evaluate the experiences of these installations with the newly implemented systems and to compare the cost and procedural benefits provided by each system

5. To determine the circumstances under which each system is suitable.

Approach

Site visits were made to Fort Meade, MD and to Fort Huachuca, AZ to observe the operation of DEH equipment maintenance shops, and to interview DEH equipment maintenance managers. At the time of the visits, Fort Meade had a microcomputer-based equipment management system (inadequate for the task), while Fort Huachuca used a manual system modelled after DA PAM 738-750, supplemented by locally developed, but limited, computerized report-generating capabilities.

Fifteen commercial systems were evaluated, and while most were found to functionally satisfy the Army's record-keeping regulations, many varied significantly in their ability to sort information and to generate reports.

From the site visits and the review of commercially available products, requirements for a vehicle and equipment management system were developed. These were discussed at a meeting of potential users in April 1987.

Based on these requirements and the review, two systems (already in use by municipal and public works organizations, and by transportation companies) were selected for the pilot tests:

1. EMS/PC by Prototype, Inc. of Kamuela, HA for installation at Fort Meade and Fort Riley. This package runs on local area networks or on standalone PC or PC/AT compatibles. Currently, the vendor sells the software, but other consultants experienced with implementing EMS/PC can provide training.

2. ShopFax by JP Systems, Inc. of Greensboro, NC, provides a turnkey system (software, hardware, installation, training, and support) called ShopFax™. This system uses bar code readers to collect work order accomplishments and to track inventory, eliminating much paperwork. However, the additional support and the need for bar code readers make this a more expensive alternative. This was installed at Fort Lee.

Mode of Technology Transfer

It is anticipated that workshops and demonstrations of the selected software systems will be made available to all DEH personnel involved in vehicle and equipment maintenance and management through the Engineering and Housing Support Center, Fort Belvoir, VA.

2 DESIRED CHARACTERISTICS OF A VEHICLE AND EQUIPMENT MANAGEMENT SYSTEM

This chapter describes the desirable capabilities of an equipment maintenance management system for DEH organizations and other equipment maintenance organizations. These capabilities are more extensive than vehicle and equipment maintenance organizations could normally implement at startup, and EMS/PC and ShopFax, each in its own style and organization, exceeded the capabilities described in this chapter.

Both ShopFax and EMS/PC have bar code capabilities, although only ShopFax had this feature during the test. Fort Meade and Fort Riley obtained this capability for EMS/PC after the test, in October 1989.

General Requirements

The general requirements of a vehicle and management system are:

1. The system should operate on a microcomputer at least as powerful as an IBM-AT, and have at least a 40 megabyte hard disk with backup capability. The computer should function as either a single station, or as a station with up to five remote terminals.

2. Data concerning equipment usage and maintenance should be collected and entered via terminal keyboard or other device for storage in a database management system. Written forms should be used only when needed for temporary record keeping until the information can be transferred to the computer.

3. Maintenance employees should be able to use programmable bar code or keyboard devices to store collected data concerning: parts taken from inventory, deliveries to inventory, and hours worked for downloading into the database management system. If this is the case:

   - Provisions must exist for any information which can be collected by bar code readers to also be entered by keyboard.

   - Any information downloaded from bar code devices must be tested for correctness and consistency, with the operator having the capability to interactively make corrections during the downloading process.

4. The programs or database management system must sort information and perform calculations with this data to generate reports and to satisfy decisionmaking needs.

5. Underlying programming language and data base management system techniques used in the modified system must enable managers and other personnel, after 2 or 3 days of training, to create (and save) formats for and generate both ad hoc and permanent reports. Such reports could include ASCII (i.e., text) files for transfer to other systems.

6. Input of ASCII files should be allowed to initialize and modify data tables and to enter/revise work orders. This latter capability is required since interfaces will eventually be developed between this system and the Army-wide system known as the Integrated Facilities System-Micro (IFS-M).[1]

7. Each user must be permitted to enter, edit, and view only data that he or she has been authorized via password.

8. The system must be capable of interfacing with IFS when the new version of IFS becomes available.

9. Higher authorities should have access to reports generated, but not to the database.

10. Daily backups with alternating media should be implemented.

Specific Capabilities

Equipment

Neither ShopFax nor EMS/PC provides good written documentation regarding data categories. At a minimum, the system should include the following list of data items to support work order management and history:

1. Equipment identifier
2. Equipment type
3. Equipment description
4. Manufacturer
5. Model number
6. Serial number
7. Warranty expiration
8. In-service information
9. Fuel and oil type
10. Depreciation and service schedules
11. Remarks

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[1]For information on IFS-M, see *Job Cost Accounting: Integrated Facilities System Mini/Micro (IFS-M) User's Manual* (U.S. Army Engineering and Housing Support Center, Fort Lee, VA, 15 Aug 88).

12. Descriptions of major components

13. Operating hours or mileage, as appropriate, and the date such reading was made.

Task Definitions

The system should minimally include the following data items required to support task definitions:

1. Task identifier

2. Task description

3. Materials or parts associated with the task

4. Default accounting code.

For PM tasks, the default scheduling information may be described in any of the following ways:

1. Time elapsed since the last occurrence

2. Hours of usage

3. Month(s) or quarter(s) in which to be done

4. Lead time for flagging.

Multiple tasks should be easily combined into single work orders. This feature may be implemented by defining task schedules as combinations of tasks. The above data elements can be applied to a task schedule.

This is especially important for PM, since multiple PMs with different scheduling requirements can exist for a single piece of equipment.

All Work Orders

Work orders should contain at least the following information:

1. Name and phone number or location of person requesting the work

2. Equipment identifier

3. Equipment type

4. Equipment description

5. Model and serial number

6. System

7. Warranty expiration (if still under warranty)

8. Accounting code

9. Description of each task to be performed

10. Remarks and special instructions.

At a minimum, the system should have the following work order planning capabilities:

1. To retrieve and combine with other work orders (preventive and corrective) for the same piece of equipment

2. To review the corrective maintenance history for a piece of equipment while preparing a work order

3. To check for availability of parts

4. To charge and reserve parts and quantities to work orders

5. To assign a status code to work orders, changeable as needed during the life of the work order. Status codes identify the status of work orders, whether they are: in estimating, in planning, approved, awaiting authorization, awaiting material, awaiting labor, ready for scheduling, in process, complete, or in any other (coded) condition. Work orders may then be selected by this code.

Preventive Maintenance

The system should have the following minimum capabilities concerning preventive maintenance:

1. To schedule PM work orders according to calendar date, time since the last PM, metered usage, metered usage since the last PM, or any combination of these criteria

2. To print PM work orders

3. To provide detailed descriptions of PM procedures on work orders

4. To print the PM workload forecast by craft and/or shop for any specified period

5. To permit the user to specify lead time for notification of PMs due

6. To assign or change the accounting code for PM tasks and equipment

7. To allow default accounting or other cost codes for PMs to a specific piece of equipment.

Corrective Work Orders

For corrective work orders, the system should have the following minimum capabilities:

1. To automatically flag corrective work orders for equipment under warranty

2. To allow review of upcoming PM requirements for inclusion in the corrective work order

3. To allow setting of priority codes for the work order

4. To flag those work orders which can be accomplished according to material deliveries

5. To associate tasks with equipment systems (e.g., electrical, body exhaust, brakes), and to track this information for individual vehicles and by groups of vehicles

6. Record reasons for part failures.

Fuel Management

The system should track fuel consumption for individual vehicles and interface with automated fuel dispensing systems.

Maintenance History and Archiving Capabilities

The system should:

1. Automatically update history at work order closeout

2. Selectively archive history based on multiple select criteria

3. Maintain a detailed work order history for equipment for at least 1 year, and provide a 5-year summary maintenance history for each piece of equipment.

Parts Inventory

At a minimum, the system should include the following list of data items for parts:

1. Description

2. National Stock Number (NSN)

3. Manufacturer part number

4. Vendors for each part, including:

   - Point of contact

   - Company name, address, phone, price

5. Equipment items or associated assembly (if applicable)

6. For stocked items, the location information, including:

   - Maximum stock item
   - Reorder point and quantity (up to three of each to handle seasonal items)
   - Row, aisle, and bin

7. Unit of order

8. Unit of issue

9. Expected lead time for procurement

10. Expiration date for parts.

The system must also:

1. Integrate inventory tracking with the purchase order system

2. Look up parts by part number, part name, or key word

3. Cross-reference equivalent parts from other vendors

4. Generate multilevel parts lists to support subassemblies

5. Flag or delete parts no longer associated with any active equipment or facility

6. Contain controls to prevent inadvertent deletion of parts still associated with active equipment or facilities

7. Automatically reflect parts issues, charges, and returns in the inventory

8. Track parts reserved or charged to work orders

9. Release or recover unused reserved parts at work order closeout

10. Track issues of parts and supplies not chargeable to specific work orders

11. Report on parts and supplies which need ordering, and generate purchase orders automatically upon request

12. Process material receipts and issues through bar coding

13. Allow multiple vendors and sources for each part

14. Assign and unassign parts used to specific work orders, either by keying in a part number or by passing a wand over an identifying bar code

15. Produce adhesive bar code labels on demand for received parts.

Purchasing

The system should:

1. Generate purchase requests to the in-house government supply system

2. Generate purchase orders to outside suppliers

3. Handle blanket purchase orders, with a maximum limit on individual and yearly charges against each order

4. Have the capability to automatically generate purchase orders for unstocked items

5. Tag orders which depend on the purchase order

6. Automatically identify work orders awaiting parts.

Employee Management

The system should contain the following data elements for each employee:

1. Name

2. Address

3. Phone

4. Employee number

5. Craft

6. Pay grade

7. Hourly rate

8. Overtime rate.

Employee labor should be chargeable to work orders on a 1/10th hour basis. Nonproductive time, such as lunch, breaks, travel, administrative, training, cleanup, sick leave, and vacation time, can also be entered into the system. The classifications of nonproductive time will be user specified. Users may set options for each type of nonproductive time to either charge the time directly to work orders, apportion it to the day's or week's work orders according to hours worked, or to charge it to an overhead or

nonproductive time account. Administrative and managerial employees' time will generally be charged to one or more nonproductive time classifications.

The system should allow entry of planned vacation, holidays, and sick leave entries in advance to simplify scheduling by supervisors.

Daily time reports should be entered into the system either by data entry screens or by downloading data recorded during the course of the day by maintenance personnel with portable, programmable bar code reading devices with built-in clock/calendars.

For work information downloaded from bar code readers, the system must check for data consistency (for example, that the parts used are appropriate to the system or vehicle, and that hours charged are reasonable), and also allow the operator to review information for any work order.

Daily Work Tracking

Although the system should allow collection of data without bar code readers, daily work data should normally be collected by bar code readers for later downloading into the computer. The portable bar code readers must be programmable to insure that mechanics enter the correct sequence of bar codes. Employees with portable bar code devices (with built-in clocks) will have one or two laminated sheets with the bar codes necessary to record:

1. The time an employee started and stopped on work orders and tasks within work orders

2. Nonproductive time by category, time started, and time stopped

3. Tasks performed by employee (for corrective work only)

4. Equipment or component failure codes (for corrective work only)

5. Parts assigned to work orders.

Work Forecasting

The system should be able to:

1. Project PM manhours needed, by craft, for any future time period

2. Project non-PM manhours needed, by craft and/or shop, for any future time period, based on past history.

Weekly projections by craft must consider known and projected absenteeism and leave, expected emergency, expected overtime, work already assigned, and expected contract labor hours available.

Work Done Under Contract

The system should process work orders performed under contract, rather than by in-house staff, and charge them to appropriate accounting codes.

Budgeting and Financial Reporting

The system must allow the establishment of annual and quarterly budgets and provide reports showing how expenditures compare to budgeted amounts. Financial reporting must be available for individual or user-specified groups of vehicles and equipment.

Reports and Inquiries

The system should collect and analyze data necessary to produce appropriate reports and/or on-line inquiries. The requirements herein are minimum requirements for predefined reports and inquiries, and do not compromise the requirements for user-definable reports. (The capabilities of EMS/PC and ShopFax [even before considering the flexible report-generating capabilities of each] exceed this basic list.)

1. Equipment reports
    - Details of any piece of equipment
    - Parts list for any piece of equipment
    - List of equipment associated with a part
    - Utilization of individual or groups of equipment
2. Maintenance reports
    - Past due work orders (either PM or corrective)
    - Work orders awaiting planning or deferred
    - Work orders awaiting scheduling
    - Active work orders by user-defined criteria
    - Work order backload (for PM and/or corrective) by craft code (expressed as number of work orders and/or estimated hours)
    - Equipment cost histories by individual equipment, by categories of equipment, and by equipment systems across categories of equipment
    - Weekly, monthly, and quarterly status and closeouts
3. Inventory-related reports
    - Inventory catalog by part or by location
    - Parts in need of reordering
    - Past-due purchase orders

- Parts usage reports for any time period
- Parts for equipment no longer in the equipment inventory

4. Purchasing-related reports
   - Parts/supplies in need of reordering
   - Print purchase orders if requested
   - Open purchase requests in summary and detail form
   - Overdue purchase orders
   - Status of blanket open purchase agreement
   - Year-to-date purchases from each supplier
5. Employee management
   - For any employee or groups of employees for any period of time, the time spent in various categories of productive and nonproductive work activities
   - Normal and overtime hours, and costs of each assigned to work orders
6. Work forecasting
   - Projected PM manhours, for a specified future period
   - Projected non-PM manhours, for a specified future period.

3 COSTS OF THE TWO SYSTEMS

Except as noted, all costs are based on September 1989 software and software training prices, estimated hardware and hardware service contract costs, without quantity discounts for software or hardware. The minimum configuration is a central computer (an 80386 processor) with three additional work stations.

EMS/PC

EMS/PC runs on a local area network served by an MS-DOS computer (an 80286 or 80386 processor) connected by appropriate cabling and network software and hardware to several work stations. Work stations may be terminals or other MS-DOS computers. Table 1 summarizes the costs of an EMS/PC system. The components of the EMS/PC system are:

1. Multiuser version of EMS/PC: ($9000 plus annual maintenance/upgrade/phone support fee of 20 percent of current retail price. The $9000 is expected to rise to $10,000 within the next year.)

2. Software to support bar coding

3. Training and installation: Prototype does not include training with EMS/PC, but on-site training is available at $400/day plus travel and expenses; includes 5 days training, $100/day expenses and $800 airfare

4. Network installation and training: only if contracted out

5. Netware: software to run local area network

6. Network server: 386 microcomputer running MS-DOS with a 70 megabyte hard disk and 2 megabytes memory (if 130 mb hard disk, add $500)

7. Work Stations: minimum configuration is three diskless Hyundai 8088 at $500 each. Options at one or more workstations: XT compatible computer (add $100/station), AT compatible computer (add $400/station), hard disk (add $400/station); these options are useful if additional applications, such as word processing, are to be run at a work station.

8. Ethernet cards: hardware interface to local area network; one for network server, one for each work station at $400 per work station

9. Printers: Two dot matrix printers; laser printer will cost an additional $1800

10. Cabling

11. Tape backup (highly recommended)

12. Portable bar code readers for maintenance personnel (seven at $800 each)

13. Optical interface for portable bar code readers

14. Two bar code wands for work stations

15. Hardware maintenance: for out-of-warranty equipment, assume 10 percent of initial hardware cost annually.

A standalone version of EMS/PC may also be bought for $5000.

ShopFax

JP Systems has no standard price for ShopFax, but provides a separate quote for each installation depending upon the hardware requirements. JP Systems typically supplies a turnkey system, although the government could purchase the hardware separately from the vendors. JP Systems uses the PICK operating system, which does not require a local area network, but instead uses terminals connected by proper cabling. ShopFax includes a 9600 baud modem for JP Systems to remotely monitor and diagnose problems, and to download system upgrades. Table 2 summarizes the costs of a network ShopFax system, assuming that the hardware is purchased separately.

Table 1

Costs of EMS/PC

Component	Initial Cost ($)	Annual Cost ($)
Multiuser version of EMS/PC	9000	1800
Bar-coding software	2000	
Training and installation	3300	
Network software	900	
Network server	4500	
Work station	1500	
Ethernet card	2000	
Printers (2 dot matrix)	1100	
Cable	500	
Tape backup	1500	
Portable bar code readers	5600	
Optical interface for portable Bar code readers	400	
Bar code wands (2)	900	
Hardware maintenance	——	1900
Totals	$33,200	$3700

The components of a ShopFax configuration comparable to the basic EMS/PC configuration above are:

1. ShopFax software: preinstallation site visit, and up to 2-person weeks of training and installation assistance (JP Systems has recently suggested halving the price to the Army)

2. Expenses for trainer/installer

3. Annual software maintenance: software upgrades; diagnosing of system problems

4. 80386 computer with 70 megabyte hard disk and 2 megabytes memory (Note: For more than four users, JP Systems currently recommends an ALTOS minicomputer which costs $17,000)

5. Multiboard with four serial ports

6. Tape backup unit

7. 9600 baud modem

8. Three work stations consisting of computer terminal ($450 each)

9. Two bar code wedges and wands ($450 each)

10. Two dot matrix printers ($650 each)

11. Cabling and miscellaneous hardware

12. Seven portable bar code readers for maintenance personnel ($800 each)

13. Optical interface for portable bar code readers

14. Annual maintenance for hardware (once warranties expire); assume 10 percent of initial hardware costs annually.

Analysis

The hardware costs of Protype's EMS/PC (with the bar coding capabilities) are comparable to the JP Systems ShopFax (with an 80386 machine). The two systems differ in installation, training, and support costs. If JP Systems does grant a large discount to Army installations, the costs of the two systems would be nearly equal. JP Systems purchases and installs the hardware, handles any hardware warranty problems, provides up to 2 weeks of on-site training, provides telephone phone support, monitors system by modem and as necessary, downloads software updates and corrections. Prototype, Inc., the vendor of EMS/PC, can provide phone monitoring for its product.

Table 2

Costs of ShopFax

Component	Initial Cost ($)	Annual Cost ($)
ShopFax software	30,000	
Training/installation	2000	
Annual software maintenance		5000
Computer	4500	
Multiboard	400	
Tape backup	2000	
9600 baud modem	600	
Work stations (3)	1350	
Bar code wedges (2)	900	
Bar code wands (2)	900	
Dot matrix printers (2)	1300	
Cable and hardware	500	
Bar code readers (7)	5600	
Optical interface	400	
Annual maintenance	———	1900
Totals	$50,450	$6900

4 PREINSTALLATION CONDITIONS AND INSTALLATION EXPERIENCE

ShopFax at Fort Lee

Prior to purchasing ShopFax, the Fort Lee equipment shop maintained several file cabinets of paper records too cumbersome for easy access in making management decisions. Three persons were involved in filling out the forms to maintain these files. Two supervisors spent most of their time ordering and retrieving parts from local suppliers. There was a preventive maintenance backlog, and as a result, mechanics were underutilized.

In January 1988, personnel from JP Systems spent 3 days installing the hardware and 1 week training the Fort Lee personnel. The system's initial configuration was the main computer, one terminal in the parts area, and one terminal in the dispatcher's office. Several months later, a terminal was added in a manager's office. Fort Lee DEH maintenance personnel installed outside cabling between buildings.

Training of the system operator (a former mechani with no previous keyboard or computer experience) took the equivalent of 3 days. The operator was guided several times through each of the steps necessary to: enter equipment descriptions, employee records, parts descriptions, preventive maintenance schedules, and locally established codes; to download and check information from mechanics' portable bar code readers; and to perform data backup procedures. At the end of this period, the operator felt reasonably confident in performing these tasks. Within several weeks, the operator had mastered most of the capabilities of ShopFax, and was able to access any report it normally produced. Within 3 months, JP Systems had enough confidence in the operator to allow him to generate simple reports, increase lengths of data fields, and install new versions of the system software from a data tape.

Training of the mechanics in the use of the bar code readers (done in groups of no more than three) required approximately 6 hours per mechanic. Each mechanic attended two 3-hour sessions. Of the seven mechanics, six quickly mastered use of the bar code readers, while one resisted the change. Management at Fort Lee was very impressed with the speed (2 weeks) and ease of converting to the automated system.

JP Systems staff have made four subsequent visits to Fort Lee, downloading several updated versions of the ShopFax software via modem and providing technical support by phone conversation and by modem.

Two factors have contributed to the degree of success of the installation. First, JP Systems has spent more time at Fort Lee working with the operator than the 10-person days usually included in their services. Second, the person operating the system has many years experience as a mechanic, and although having no computer and almost no typing experience, has taken a great personal interest in the success of the ShopFax. His experience as a mechanic has enabled him to obtain maximum benefit from the system.

EMS/PC at Fort Riley

Fort Riley has had a relatively well-run equipment shop for some time; they never had a serious problem with breakdowns. All record keeping was performed manually until April 1988, when a single user version of EMS/PC was installed. The operator of the EMS/PC system is the dispatcher, whose

previous training did not include equipment maintenance. The shop has eight mechanics, one tire man, and one welder.

Although Fort Riley does have a capable management information systems staff, they were not available to the equipment maintenance and management personnel. As a result, some relatively simple problems, such as misconfiguration of memory-resident programs, delayed the successful implementation of EMS/PC. Many of the problems could have been solved had the vendor of EMS/PC been able to dial up the computer at Fort Riley. Provisions have been made to get the necessary software to do this in the future. In fiscal year 1989, Fort Riley planned to obtain bar code readers for use with EMS/PC, and to expand to a network environment.

EMS/PC at Fort Meade

Fort Meade has also had a relatively well-run equipment shop for some time. All record keeping was performed manually until April 1988, when a single-user version of EMS/PC was installed in one of Fort Meade's three equipment shops. The shop has seven mechanics and one foreman. The Chief of the Equipment Branch, an experienced fleet manager, oversees all three shops and has taken an active role in overseeing the implementation of EMS/PC. Prior to using EMS/PC, the equipment branch used a less powerful equipment management system, which is still in use in the two other shops.

Although the software was delivered in April 1988 in a multi-user configuration, it has been used in only a single-user configuration mode. Fort Meade planned to obtain bar code readers for use with EMS/PC in fiscal year 1989, and eventually plans to expand use of EMS/PC to the other two shops.

The Branch Chief has indicated that, with better information, complete implementation of EMS/PC would have taken 6 weeks rather than 10 months. The operator of the EMS/PC system, charged with performing all the data entry to set up the system, was the parts room clerk, whose previous training did not include equipment maintenance. The process could have been shortened by entering only those data items needed to begin using EMS/PC and to create useful reports from the EMS/PC database. Moreover, only part of the whole inventory (over 2700 different types of parts) was needed to bring the system up because many are used rarely, and stocked only to avoid delays in the procurement cycle.

Fort Meade had difficulties setting up the system due to a lack of the necessary expertise with microcomputers. As with Fort Riley, the ability to phone the vendor would have helped.

Unlike the personnel at Fort Lee, Fort Meade staff lacked an extensive background in equipment maintenance, had other duties which limited the time spent on creating the necessary databases for EMS/PC, and received no personalized training.

5 BENEFITS

Computerizing equipment management records provides two major benefits. First, the organization entirely revamps its operating procedures. Automatic management systems can provide great improvements in scheduling of PM, identifying parts in inventory, reducing administrative staff, and performing inventory management and control. The second benefit is that better information is available for making decisions, because the computer can quickly sort through and summarize data from hundreds of work orders. For example, the system allows managers to compare the reliability and operating costs of different pieces of equipment, and to better assess the capabilities of mechanics.

ShopFax at Fort Lee

Improved Record Keeping

Bar coding has eliminated most keying in of data, has improved accuracy, and has freed the system operator to spend more time compiling information needed to run the shop more efficiently.

Today, one person (a former mechanic) using the computer performs nearly all the record keeping for both equipment and inventory management. These records are now being used to lower the costs of shop operations.

A second person assists in the record keeping and does most of the parts running. This second person formerly spent 30 hours per month filling out the trip ticket forms carried in all vehicles and transposing mileage information from the returned trip tickets. Now these forms are generated by computer in 2 hours, and mileage information is recorded during refueling.

In the first year, the equivalent of 2 1/4 person-years annually has been saved. (One less supervisor and one less data entry clerk are now used, plus the 30 hours per month no longer spent completing monthly trip tickets.) Assuming an average of $15 an hour for these personnel, annual savings are:

1700 hours/year x $15/hour x 2.25 = $57,375.

Some part of this staff reduction savings can be attributed to the ability to identify the manufacturers and National Stock Numbers for parts. (See the discussion of parts inventory management below.)

Improved Mechanic Efficiency

The former mechanic running the ShopFax system at Fort Lee indicates that a 20 percent increase in mechanic efficiency has resulted. Better maintenance efficiency means that mechanics are no longer called to do emergency restarts in the field. Hours worked on each work order are no longer simply estimated at the end of the day or week, since mechanics realize that their time is carefully monitored. The system operator now informally assigns mechanics to tasks on which they are most efficient. Assuming only a 10 percent efficiency increase, the resulting savings are:

.10 x 7 mechanics x $15.00/hour/mechanic x 1700 hours/year = $17,850.

Preventive Maintenance

All PM backlog has been eliminated. Before the new system a PM backlog of 10 to 12 pieces of equipment existed. PM is now scheduled by date and/or usage, rather than by calendar dates. As a result, personnel from other shops now have less idle time for their equipment.

With PM accurately monitored and scheduled, breakdowns in the field have decreased from 30 per month to three or four. Better PM has resulted in fewer field breakdowns for bad hoses, bad cables, and ignition problems. Previously, brakes would fail in the field five or six times per year. Now, over a recent 6 month period, only one brake failure has occurred. Previously, one mechanic's primary task was making field calls. Now field calls are handled as needed. The resulting savings in mechanics' time is:

26 field calls/month x 1.5 hours/field call (estimated) x $15.00/hour x 12 months/year = $7020.

Fewer breakdowns also (a) decrease idle time for vehicle users, and (b) eliminate much of the shifting of personnel and equipment resources brought about by breakdowns. Assuming the same wage rates and hours saved for vehicle users as for mechanics, an additional $7020 is saved.

The system operator estimated that in the past, at least twice a month, a PM task (e.g., oil and grease) was done as part of a major repair, and then duplicated several weeks later as part of a scheduled PM. This no longer happens.

Proper Selection of Equipment To Excess and Lease

Equipment usage records are now monitored, and well-informed lease or buy decisions for heavy equipment can now be made. In the past, equipment was sometimes unknowingly turned in for replacement soon after overhaul of one or more major components. Now repair histories are reviewed before turning in equipment. For example, a 1976 International dump truck received a new transmission in March 1988. In July 1988, Fort Lee received a new dump truck, requiring the excessing of an old one. In this instance, the 1976 truck with the new transmission was kept. In a similar situation, the previous year, a dump truck with a new transmission and engine was turned in because the person making the selection had no easy way to access the repair history of the dump truck inventory, and therefore considered only the age of the truck.

Warranty Monitoring

Warranties on parts and outside repairs are now accurately kept. This includes basic vehicle warranty, adjustments to basic vehicle warranty, and extended warranties. The vendor, installer, and date of installation of parts are now tracked.

Parts Inventory Management

For the first time, the fast moving parts which should be stocked have been identified, decreasing the total parts by 50 percent. Parts are now cross-referenced among vehicles instead of being stocked separately. The number of local purchase orders now generated has been reduced from three or four to two or three.

Previously, ordering a part required 20 to 40 minutes to search through manufacturer catalogues and to identify the government stock number for the part. Now, these numbers and the corresponding equipment are recorded on the computer for quick future retrieval.

The large database of parts associated with each equipment item sometimes makes it possible for a necessary part to be identified without an operator bringing the item to the shop, or even having a mechanic visit the downed piece of equipment.

Parts orders now reflect anticipated requirements. Parts for PM over the next 60 days are now accurately stocked. Parts needs for failures can be intelligently anticipated. If a part on a vehicle fails, and Fort Lee has several such vehicles of similar age, several such parts will be ordered in anticipation of similar failures, and the reorder point and quantity for the part will be set appropriately. For example, Fort Lee has 10 Dodge vans, all approximately 4 years old. When the door latch on one recently failed, three latches were reordered, and the reorder point was set to one. However, if equipment is expected to be excessed before some parts are needed, only a low inventory of one or two would be maintained. For example, if a set of trucks of similar model and age may have had brakes replaced in the past year, only one or two sets of parts needed for a major brake overhaul would be stocked. With the ability to anticipate the need for parts more effectively, more parts are ordered from GSA, rather than from local sources, at typical savings of 40 to 60 percent.

Now fewer pieces of equipment are deadlined simultaneously (one or two rather than seven or eight), because the installation supply now sees fewer orders, and those designated as high priority receive prompt attention.

EMS/PC at Fort Riley

Better Record Keeping

The computerized record-keeping system captures both labor and material for work performed on equipment by outside vendors.

Mechanic Efficiency

Mechanics now spend less time completing paper work because all work orders are preprinted, and less time searching for parts because parts ordered for a specific item (but which do not deadline the item), are now flagged in the computer when received. When a vehicle comes in for PM and the PM order is printed, the arrived part is indicated. Previously, mechanics would have to go to the parts room and check records for any arrived parts.

Because of the improved efficiency of the system, the shop supervisor estimates that the mechanics are 10 percent more productive. This translates into an annual cost savings of:

$16.76/hour/mechanic x 10 mechanics (including a welder and a tire changer)
x 1700 hours/year x 0.10 = to $25,400.

Parts and Warranty Monitoring

Fort Riley is considering converting its parts room to an outside contracted service and thus has delayed converting its parts room to operate under EMS/PC.

EMS/PC at Fort Meade

The equipment branch chief indicated some of the benefits that EMS/PC has and can produce. As an experienced fleet manager, he has identified how EMS/PC can help provide the information he needs to manage, but with only one person working part time to implement EMS/PC, some of these benefits have yet to be realized.

Better Record Keeping and Report Generation

The equipment branch chief can get information about specific equipment or groups of equipment very quickly. Annual reports for FORSCOM can be produced in several hours rather than several days.

The two GS-3 secretaries in the Equipment Branch Chief's Office no longer spend 2 hours each day preparing PM Schedules, creating repair tickets, and entering repair orders into the computer. The parts room clerk now does this via computer. Tangible annual savings are therefore 4 hours daily (or 1/2 a GS-3 year), approximately $7,000.

Improved Quality of Preventive Maintenance

Now specific tasks to be performed for each PM repair order are printed out and explicitly checked off by mechanics. The Equipment Branch Chief has stated that the quality of PM is now better (fewer tasks are missed), and that this will result in fewer breakdowns, even though this experience has not yet been quantified.

Parts Management

The parts clerk and mechanics spend less time searching for parts, because the computer indicates where parts are and whether they are out of stock. Fewer parts require stocking; eventually the number of parts stocked will be reduced from over 2700 to under 2000 based on usage history. Lists of parts in need of reordering can now be generated automatically instead of by physical inventory.

Better Management of Labor

The Equipment Branch Chief is now establishing procedures for mechanics to differentiate between indirect labor (parts retrieval, meetings, training, road calls, breaks, etc.) and direct labor (time actually spent on work orders). This will eventually result in better evaluation of mechanic productivity, and better costing of Equipment Branch services.

Based on reports indicating the time spent by various mechanics on certain tasks, standard times for each task are being developed. The Equipment Branch Chief said that this is easily done for PM work

orders, which are somewhat repetitive, but is more difficult for many repair work orders, where the cause of the failure may often determine the time required for repair (e.g., the same problem may be caused by a worn seal or a cracked casing).

Based on these same reports, the Equipment Branch Chief and the shop foreman have discussed how to identify the mechanics most skilled at specific types of work orders. The Equipment Branch Chief believes that such discussions have resulted in the foreman assigning mechanics to tasks at which they are most skilled.

6 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Criteria were developed for selection of commercially available, computer-based vehicle and equipment maintenance management systems for the equipment shops of Army installation DEH organizations.

Based on these criteria, JP Systems' ShopFax and Prototype's EMS/PC were selected for further testing. Only in these two equipment management systems has bar coding been totally integrated. Both products have comprehensive analytical and report-writing capabilities.

ShopFax was tested at Fort Lee, VA, and EMS/PC was tested at Fort Riley, KS and at Fort Meade, MD.

If the in-house staff has the experience to install a personal computer network, or if a network is already in place with sufficient disk space (minimum of 70 megabytes), the EMS/PC is the less expensive choice. If JP Systems discounts its software in competitive procurements, the costs for installing either EMS/PC or ShopFax will be nearly equal.

The benefits and savings described at the three test installations show that, to date, ShopFax at Fort Lee (with $70,140 of tangible benefits and several intangible benefits) has produced substantially greater benefits than EMS/PC at Fort Riley ($25,800 tangible benefits) or at Fort Meade ($7,000 of tangible benefits). This apparent cost advantage may be offset by subjective factors pertaining to individual installations. Of the three installations, Fort Lee's equipment shop required the most changes to achieve effective operations. Many of the improvements and benefits which accrued at Fort Lee were already reflected in practices at Fort Riley and Fort Meade without a computerized system. For instance, Fort Riley and Fort Meade never had a serious problem with missed preventive maintenance, excessive field breakdowns, or lost time related to mechanics' field calls. Some benefits, especially those concerning the management of parts inventory, have not yet accrued at Fort Meade and Fort Riley because the parts databases at these installations had not been fully established. The improved efficiency of mechanics with bar code readers could not be confirmed or realized at Fort Riley and Fort Meade because the readers were not present.

EMS/PC can be installed on a standalone computer without bar coding for a total cost of $7000 ($5000 for the software system, and $2000 for an IBM AT compatible microcomputer). Users may upgrade to multi-user and/or bar-coding systems as the need arises. ShopFax is an inherently multi-user system which requires purchase of a turnkey system at a much higher cost, although JP Systems will negotiate to provide partal systems to users who do not require the entire package.

EMS/PC is DOS-compatible; ShopFax does not use a DOS-compatible operating system. Data exchanges, however, can be arranged to DOS applications and computers.

Successful implementation of either EMS/PC or ShopFax in any DEH requires a substantial investment in establishing the initial databases (typically 2 to 3 person-months of properly directed effort), and either proper training, or both fleet management and computer database experience. An installation receiving either fleet and equipment management system must make the necessary staff commitment.

EMS/PC can provide training as part of a purchase contract; even without contracted training, one or two individuals with solid collective skills in fleet management and data base applications could implement EMS/PC. JP systems provides and requires training as part of their package.

Each installation DEH may determine which system is more appropriate for its use by evaluating the conditions that characterize the installation environment.

EMS/PC is preferable to ShopFax under the following conditions:

1. If budget constraints preclude the purchase of a multiuser system

2. If budget constraints preclude the purchase of a bar code reader

3. If the installation DEH has highly skilled fleet managers

4. If the installation DEH staff has good computer skills, both in system management and operation of database software

5. If the system is to operate in a DOS environment or with other DOS applications on a network.

ShopFax is preferable to EMS/PC under the following conditions:

1. If the installation DEH fleet management experience is low

2. If the system will operate in a multiuser environment and the installation DEH fleet management has little expertise in the use of microcomputer hardware or software.

Recommendations

It is recommended that, before an installation sets up the databases for either of these products, the decisions be made regarding the classification of equipment, the classification of equipment systems, and the establishment of PM schedules. Additionally, end users of either system must determine which data items are necessary to initiate use of the fleet management system; neither vendor provides good written documentation concerning these decisions.

If EMS/PC is to be expanded to other Army bases, it is recommended that a brochure on practices and procedures be authored and published to simplify the implementation process.

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